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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

COMPARISONS OF AMERICAN AND BRITISH FOAM VISCOSITY MEASUREMENTS

by

R. J. French

Summary

Comparisons have been made between the measurements of foam viscosity obtained with the Joint Fire Research Organization and the U.S. Naval Research Laboratory versions of a vane type of viscometer, and a modified version of the Amsel ball-type viscometer, produced by the Naval Research Laboratory.

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Introduction

Most fire-fighting foams do not exhibit the characteristics of a Newtonian fluid, but foam viscosity can be measured by methods closely allied to normal viscosity determinations. The 'fluidity' of a foam may then be defined as the inverse of its viscosity.

In this country the torsional vane viscometer has generally been used to measure viscosity, which is stated in terms of the critical shear stress of the foam in dyne/cm^2 or lb/ft^2 (480 dyne/cm^2 is equivalent to 1 lb/sq.ft^2). The fluidity could be expressed in the inverse units.

In the United States of America the fluidity has generally been determined by measuring the '25 per cent drainage time' of a foam in a standard shallow pan. It has been shown (1) that this property can be related directly to the critical shear stress of the foam, independently of expansion and concentration. This property is not, however, a direct indication of how a foam drains on a burning liquid but can only be used as a comparative measure of fluidity for any particular compound.

The Naval Research Laboratory has also used a modification of Amsel's viscometer (2) in which a wooden sphere is drawn upwards at a constant velocity through the foam, the pull on the ball being measured. The same laboratory has also produced a torsional vane viscometer. The vane of this instrument is thicker than that of the British version, but is of the same depth and breadth. The torsion wire has a slightly greater torsional constant, and the bowl is smaller.

These two American instruments were recently made available to the Joint Fire Research Organization by the U. S. Naval Research Laboratory so that results obtained with them and the British torsional vane viscometer could be compared.

Procedure

To overcome the difficulties of operating the American vane viscometer on the British electrical supply voltage and frequency, the wire, vane and bowl of the Naval Research Laboratory instrument were used in conjunction with a British motorised turntable, operated at a similar speed. Critical shear stress measurements were made with both the vane viscometers, for foams produced by the laboratory foam generator with critical shear stresses up to 1400 dynes/cm^2, from high and low viscosity British foam compounds. The results of these comparisons are shown in fig. 1, from which it can be seen that there is good experimental agreement between the two instruments.

In the case of the ball viscometer the electrical supply difficulties were overcome by supplying 110 volts to the motor at 50 cycle/sec and obtaining the correct linear speed of pull by fitting a pulley of 20 per cent greater diameter to correct for the the lower rotational speed obtained at this frequency. The pull, as read from the scale, was recorded for various foams made from British compounds in 1, 3 and 6 per cent concentrations. The critical shear stress of these foams was determined at the same time. The relationship between the two properties is shown in fig. 2, and was found to be linear over most of the range.

Conclusions

Direct comparison between foam viscosity measurements obtained with the three instruments can readily be made.

References

1. SAVAGE, NICOLA. The relation between critical shear stress and '25 per cent drainage time' of air-foam. Department of Scientific and Industrial Research and Fire Offices' Committee, Joint Fire Research Organization F.R. Note No. 344/1958, March 1958.

2. TUVE, R. L. and PETERSON, H. B. A study of some mechanical foams and their uses for extinguishing tank fires. Naval Research Laboratory, N.R.L. Report No. 3275, August 1950.

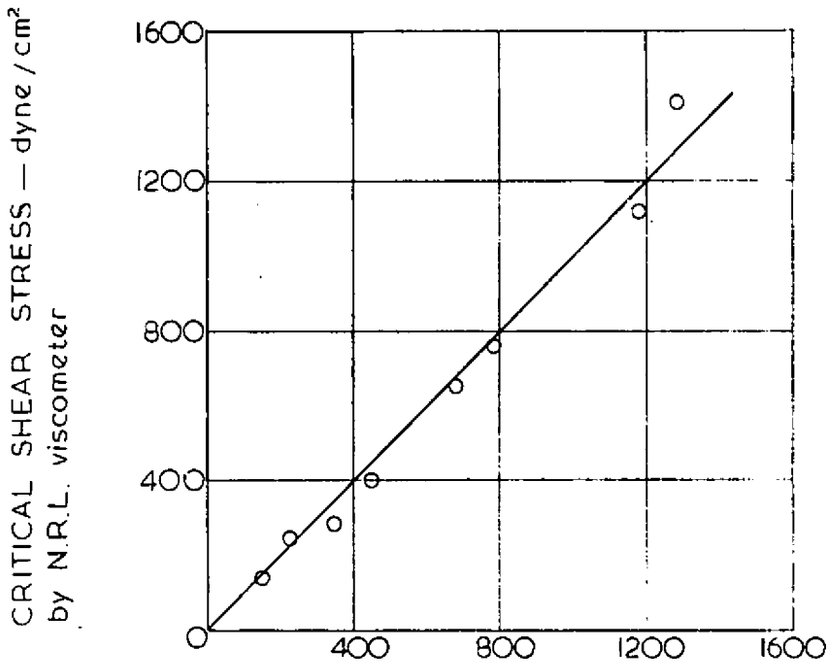

FIG.1. COMPARISON BETWEEN N.R.L & J.F.R.O. TORSIONAL VANE VISCOMETER

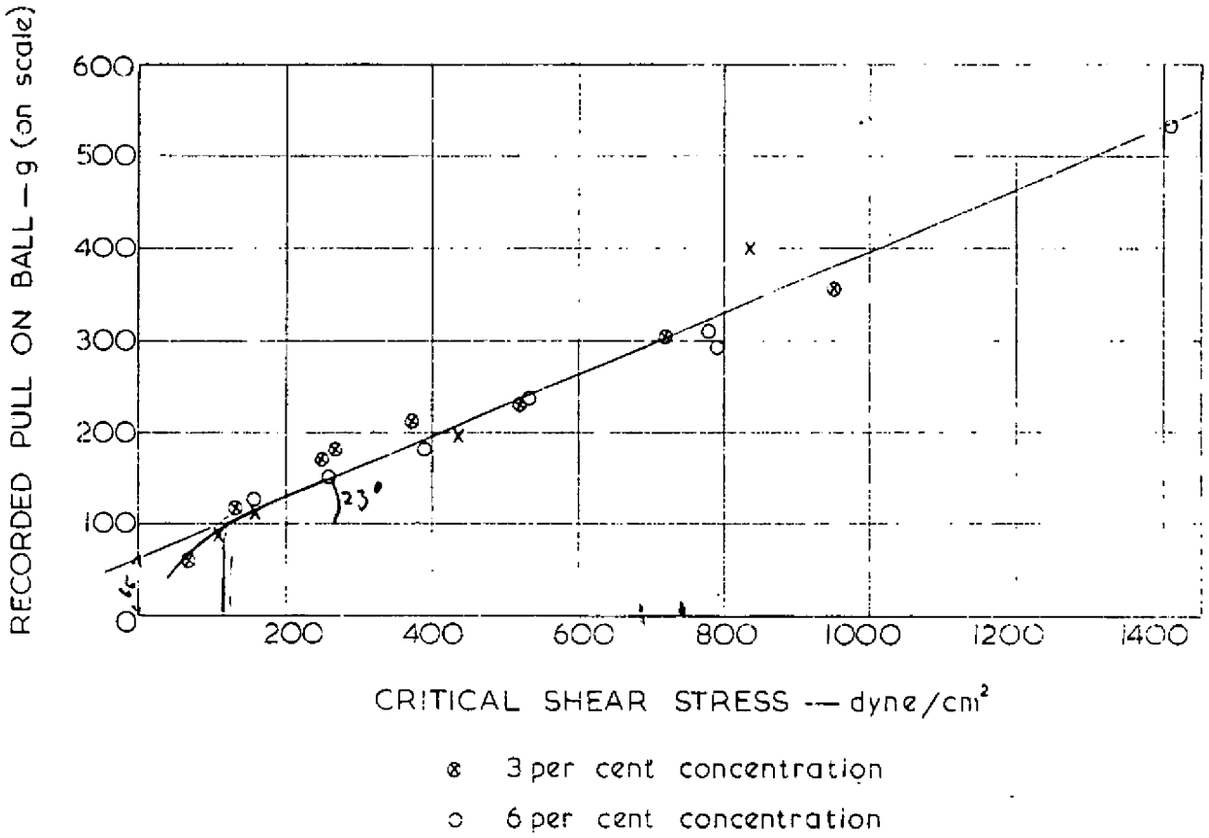

FIG.2 COMPARISON BETWEEN N.R.L BALL VISCOMETER & TORSIONAL VANE VISCOMETER

Dynes = grams × 3 − 200.